Integrated Protection Against Lyctid Beetle Infestations

Part I. — The Basis for Developing Beetle Preventive Measures for Use by Hardwood Industries

Lonnie H. Williams

United States Department of Agriculture

Forest Service

Southern Forest Experiment Station
New Orleans, LA
1985

SUMMARY

Justification is provided for use of integrated protection (use of a combination of preventive measures) programs by hardwood industries for prevention of lyctid beetle damage to lumber and for long-term protection of secondary manufactured products. Current beetle preventive measures and their limitations are discussed. An example of an integrated protection program for hardwood products industries is given, and information on beetle biology is also summarized.

INTRODUCTION

The Wood Products Insect Research Project at Gulfport, Miss., is studying preventive measures for lyctid beetles (true powderpost beetles, Coleoptera: Lyctidae) to be used by hardwood industries. Use of preventive measures by sawmillers and manufacturers is necessary because lyctid beetles most often infest hardwood lumber and secondary manufactured products such as flooring, furniture, millwork, moulding, and picture framing during manufacturing and distribution. Prevention of infestations in lumber and provision of long-term protection for other products will require integrated protection programs (use of a combination of preventive measures) by hardwood industries to totally avoid beetle-damaged wood and related product liability expenses. Integrated protection is an approach to beetle prevention that could considerably improve the utilization of high-value hardwood resources and the efficiency of pesticide use in the United States.

This paper provides justification for the integrated protection approach and precedes a planned series of research papers on beetle preventive measures. Questions that hardwood industry members might have about the prevention of beetles and the integrated protection approach are anticipated and answered. Because prevention of damage is probably of most interest to industry, information on beetle biology is summarized in the Appendix.

How Important is the Lyctid Beetle Problem?

Beetle-caused losses undoubtedly total millions of dollars annually, but an accurate national total of losses is unknown. Compilation of losses is difficult because infested products often become widely distributed, and businesses are understandably reluctant to admit that they have experienced beetle problems.

The survey discussed by Williams and LaFage (1979) indicates that the loss per infestation averages over $9,000, that most infestations occur in the South, and

that over half of the infestations were reported by firms dealing in products only. Some reasons for these results are: (1) hardwood manufacturers are concentrated in the warm and humid southern climate, which is favorable to beetles; (2) many beetle- susceptible imported hardwoods enter through southern ports and are manufactured into products nearby; and (3) beetle damage is more easily detected in products because the passage of time during the manufacture and distribution of products is sufficient for completion of the life cycle of the beetles. Therefore, adults have made external signs of damage (holes in wood surfaces).

Why Better Prevention of Beetles Seems Justified?

Inquiries have been received from all regions of the country about beetle infestations in both domestic and imported hardwoods. My impression from these inquiries is that most people do not think their firm's products were infested with beetles when sold. This result is not surprising because wood may contain eggs or larvae for a year or more with no external signs of damage, and lumber or other products often become infested during distribution and storage. The following examples suggest that measures giving long-term beetle protection for products would be well-received, if these measures were economical, effective, and safe to use.

Example 1. — Many shipments of unseasoned pecan lumber were made during 1982 from Mississippi to North Carolina for processing into furniture. Ten to 25 percent of the lumber (valued at $700 per thousand board feet) was useless because it was so badly damaged by beetles and/or decay. Many damaged shipments were accepted, but some later shipments were returned to suppliers.

Example 2. — Ash lumber was sawn in Tennessee, kiln-dried in Louisiana, shipped to a distributor in California, and sold to a cabinetmaker who found that installed cabinets were soon defaced by emerging lyctid beetles. Lawsuits were filed by product liability insurers in California against the lumber broker in Louisiana, who did not have such insurance, resulting in litigation expenses in both California and Louisiana for the broker.

Example 3. — Banak lumber was imported into Alabama and shipped to a picture frame manufacturer in Georgia who kiln-dried and processed the lumber into mouldings. Some mouldings were distributed to a frameshop in Mississippi, where beetles emerged from an infested frame and penetrated a $400 painting. The framer refunded the customer's expenses of framing and offered to replace the frame, but the customer refused and went to another framer.

Did these infestations result as an "act of God" or from failure to use appropriate preventive measures? With increasing frequency, product liability lawsuits are filed to

find an answer. However, exactly when attacks begin and who is responsible for damages often cannot be determined, even with knowledge of the entire history of the movement, processing, and storage of lumber and products. Thus, lawsuits often do not satisfactorily resolve problems for customers or businesses. Beetle-caused losses include product liability claims, returned shipments, remedial control expenses, product replacement costs, damaged business relations, and expenses of litigation, all of which undoubtedly raise operating expenses and negatively affect consumer confidence. More importantly, the money spent or lost as a result of these losses does not improve business efficiency or the utilization of wood.

Computer-controlled sawmills are now in use, and looking to the future, many firms are considering use of laser-beam cutting and moulding equipment or robotics to improve efficiency and minimize waste. However, beetle-damaged lumber and beetle-related losses for manufactured products are accepted even though existing technology can be developed to avoid such losses. I suggest that use of appropriate measures to prevent beetle-caused losses would improve business efficiency and conserve wood, as does high technology processing equipment. Because supplies of select-quality domestic hardwoods such as ash, oak, pecan, walnut, and various imported hardwoods are decreasing, better utilization of these resources through prevention of beetle damage is economically justified and can be provided for a few cents per board foot. In the future, the necessity for protection from beetle infestations likely will increase because small domestic trees with a lot of beetle-susceptible sapwood and more beetle-susceptible tropical hardwood species will be used.

Also, U.S. firms now have intense competition, with more processing of lumber and product components taking place in foreign countries. Imports of furniture and parts increased 95 percent from 1977 to 1982 and could account for 25 percent of the total U.S. furniture market during the next 2 years (Anon. 1984). These imports include domestic hardwood parts that were machined in foreign countries. This practice increases the time that untreated, unfinished wood is stored, which, if done in warm climates, increases the risk of beetle infestations. Because U.S. firms probably will be responsible for losses, firms should be so managed that infestations are prevented in both U.S. and foreign components. Use of an integrated protection program for lyctid beetle prevention could help achieve such management.

What is Integrated Protection for Lyctid Beetle Prevention?

One definition of "integrated" is "composed of separate parts that are united to form a more complete, coordinated entity." I use "integrated" with protection to mean

that several preventive measures must be used in combination to prevent lyctid beetle damage to hardwood lumber and other products. Treating unfinished products with an insecticide after manufacturing is integrated protection because wood suppliers and manufacturers must use other preventive measures such as sanitation, stock rotation, and prompt use of properly kiln-dried wood. Thus, "integrated protection" identifies better than prevention the necessity of using several measures to protect lumber and secondary manufactured products.

How Can Firms Determine if Integrated Protection is Needed?

Whether integrated protection is desirable depends upon the firm's operations that affect chances of having beetle infestations. For example, the risk of having infestations would be high if: (1) a firm uses large volumes of many susceptible woods from many suppliers; (2) either air-dried or kiln-dried lumber is stored for a few weeks during warm weather; (3) products are stored for several months or more during distribution; (4) the climate is favorable to beetles (warm and humid) at locations of wood suppliers, manufacturers, distributors, or customers; and (5) wood is air-dried and made into products with no preventive treatments.

What Chemicals and Other Measures Currently May Be Used for Prevention?

Chemicals federally labelled for prevention and control of lyctid beetles include the insecticides — Ambrodan® (endosulfan), Dursban® TC (chlorpyrifos), many formulations of lindane, and the wood preservatives — pentachlorophenol and TIM-BOR® (disodium octaborate tetrahydrate). Ambrodan® (currently not marketed) and lindane are chlorinated hydrocarbons; Dursban® is an organophosphate; and TIM-BOR® is the element boron as a highly water soluble borate salt. Ambrodan® and lindane are labelled for use on logs; these two chemicals and TIM-BOR® are labelled for use on lumber. Dursban® TC and some formulations of lindane are labelled for brushing or spraying on structural wood in use. Concentrates of insecticides and pentachlorophenol are sold only to licensed pest control operators or commercial users who dilute them in oil or water before use. Sale and use of diluted formulations of pentachlorophenol are also restricted to licensed users. TIM-BOR® may be purchased and used by anyone as a concentrated solution in water but should only be applied as directed to unseasoned wood. Only Xylamon®, a lindane formulation in a refined oil, is sold to anyone as a diluted, ready-to-use product. Dursban® WT (label in preparation) is proposed for application by brushing, dipping, pressure treating, or spraying on logs and lumber. The fumigant gases methyl bromide

and Vikane® (sulfuryl fluoride) are sometimes used for prevention by routinely fumigating all incoming or outgoing wood shipments.

Nonchemical measures include: (1) sanitation, which is prompt disposal of all wood waste that could serve as a breeding site for beetles by burning for fuel, disintegrating for manufacture of composite products, or burying in municipal waste sites; (2) prompt use of raw materials and first in/first out stock rotation of manufactured products; and (3) a beetle sterilization step in the dry-kiln schedule.

What are the Limitations of Current Preventive Measures?

Sanitation, stock rotation, fumigation, and dry-kiln sterilization provide no residual protection but do help limit the spread of infestations. Insecticides provide residual protection, but treated exterior surfaces of lumber are removed by processing. Thus, a second application to unfinished products after manufacturing is needed for continued protection. The second application rarely is done, partially because lindane is a suspected carcinogen and Dursban® lacks sufficent testing (Anon. 1983). Also, manufacturers fear that treatment will affect finishes or dimensional tolerances.

What Research Must Be Done to Implement Integrated Protection?

Phases of needed research are: (1) laboratory tests of the effectiveness of preventive measures, (2) commercial tests of effective measures to prove that they are practical for industry use, and (3) preparation of guidelines for the use of measures by industry. Preventive measures being studied include: (1) treatment of unseasoned wood by dip-diffusion with boron compounds such as TIM-BOR®, AM-BOR-S® (ammonium pentaborate-sodium sulphate), or AM-BOR-P® ammonium pentaborate-sodium phosphate); (2) treatment of air-dried wood by pressure treatment with boron compunds; and (3) treatment of unfinished manufactured products with Dursban®. Insect growth regulators, antimicrobial chemicals, and additional insecticides also may be tested for use on manufactured products. Most results have not yet been published, but Williams (1984) reported that the first measure has been successfully used commercially for over 2 years by a U.S. manufacturer of mouldings made from a Brazilian hardwood. Also, commercial tests are in progress for the third measure.

Why Are Many Different Preventive Measures Being Studied?

If several effective measures are available, individual firms may select measures that are best suited to their

operations and facilities. When wood is treated by dip-diffusion or pressure treatment with boron compounds, beetle-susceptible sapwood should be penetrated completely by boron; no other treatment should be needed, even after wood processing operations. Because dip-diffusion treatment must be done at sawmills while wood is unseasoned and because pressure treatment requires expensive treating equipment, boron treatments may not be desired by many firms. Moreover, boron-treated wood may not be available from wood suppliers. Therefore, treatment of unfinished products with insecticides is also being studied as another method of providing residual protection for products. However, the assumption is made that proper kiln-drying followed by prompt shipment and prompt use will avoid beetle infestations in wood before manufacturing.

How Would Preventive Measures Be Used in An Integrated Protection Program?

Figure 1 provides an example program that shows how preventive measures could be used by hardwood industries. However, additional research, primarily on development of effective treatment procedures in cooperation with industry, is needed for preventive measures 1, 2, and 5. Manufacturers of flooring, furniture, millwork, and trim moulding could, individually or as associations, specify that their purchases of domestic hardwood lumber be treated by dip diffusion with boron at the sawmill. They could also specify that tropical hardwoods be pressure-treated with boron before or after importation. Or, manufacturers may use measure 5, if they believe that measures 3 or 4 will be done. Competition possibly may lead to widespread use and treatment specifications by wood products associations for the most effective measures.

Why is Industry Cooperation Needed?

Industry cooperation in commercial tests will help develop practical measures and the transfer of knowledge that is needed for use of preventive measures. For example, cooperation with the picture frame industry has resulted in the transfer of much knowledge about beetles and their prevention with minimal expenditure of Federal tax dollars and with the least delay (Anon. 1982, 1983; Williams 1982a, b). Furthermore, a comprehensive review of forest products utilization research in the USDA Forest Service (Marra and others 1984) stresses that research and industry cooperation must be expanded in the future as Federal research budgets decline. The review also states that such cooperation is most appropriate for the type of research described in this paper.

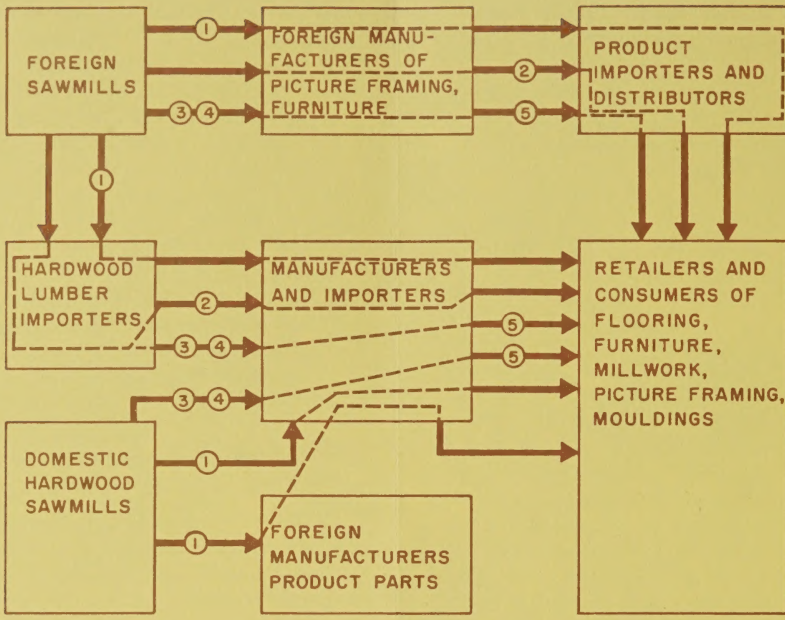

Figure 1. — An example of an integrated protection program that suggests the use of lyctid beetle preventive measures by hardwood industries. Beginning at the sawmills, follow the solid or dashed arrows indicating the path of movement of wood until a circled number indicates that a preventive measure was applied. If no other number appears along the path, the one treatment will provide protection until the product is in the consumer's hands. Beetle preventive measures:

1. Dip-diffusion treatment of unseasoned lumber with TIM-BOR® at sawmills.
2. Pressure treatment of lumber with boron compounds by importers or manufacturers.
3. Prompt use of properly kiln-dried lumber.
4. Ambrodan®, Dursban® WT, or lindane treatment of lumber being air-dried.
5. Dursban® WT or Xylamon® treatment of unfinsihed products by manufacturers.

Other useful measures for everyone — stock rotation, periodic inspections, and sanitation (removal of scraps that could be breeding sites for beetles).

LITERATURE CITED

Anon. Eating away at your profits — the lyctid (powder-post) beetle. Decor. 102(10): 246–250, 252, 254; 1982.

Anon. PPFA lyctid beetle survey results reanalyzed by Williams. Framing industry uses $1.1 billion worth of moulding annually. Framer. 6(10): 5; 1983.

Anon. HDMA to conduct study of U.S. dimension industry. National Hardwood Magazine. 58(1): 42–43, 57–58; 1984.

Berni, C. A.; Bolza, Eleanor; Christensen, F. J. South American Timbers — The characteristics, properties, and uses of 190 species. East Melbourne, Victoria, Australia: CSIRO; 1979. 229 p.

Bolza, Eleanor; Keating, W. G. African Timbers — The properties, uses, and characteristics of 700 species. East Melbourne, Victoria, Australia: CSIRO; 1972. 722 p.

Keating, W. G.; Bolza, Eleanor. Characteristics, properties, and uses of 362 timber species or species-groups from Southeast Asia, Northern Australia, and the Pacific Region. College Station, TX: Texas A&M University Press; 1982. 362 p.

LaFage, Jeffery P.; Williams, Lonnie H. Lyctid beetles: Recognition, prevention, control. Circ. No. 106, March, Baton Rouge, LA: Louisiana Agricultural Experiment Station and Louisiana State University; 1979. 12 p.

Marra, George G.; Tuomi, Roger L.; Erickson, John R. [and others]. Program direction for forest products uti-

lization research in the Forest Service. Washington, DC: U.S. Department of Agriculture, Forest Service; January 1984. 39 p., Appendices A-F.
Williams, Lonnie H. Research tackles the threat of beetles to the framing industry. Part I. Art Business News. 9(7): 1, 10–12; 1982a.
Williams, Lonnie H. Research tackles the threat of beetles to the framing industry. Part II. Art Business News. 9(8): 3, 6; 1982b.
Williams, Lonnie H. Dip-diffusion treatment of unseasoned hardwood lumber with boron compounds for prevention of beetles in lumber and other products. In: Pathways to increased cost effectiveness in management and utilization of eastern hardwoods: Proceedings, twelfth annual hardwood symposium of the Hardwood Research Council; 1984 May 8–11; Cashiers, NC. Hardwood Research Council. 1984: 154–163.
Williams, Lonnie H.; LaFage, Jeffery P. Tracking the lyctid beetle. Southern Lumberman. 239(2968): 112; 1979.

APPENDIX

Many reports on the biology of common lyctid species are summarized as follows. Included are those frequently introduced with wood *(Lyctus brunneus* [Stephens], *L. africanus* Lesne, and *Minthea rugicollis* [Walker]) and the native U.S. species, *L. planicollis* LeConte and *Trogoxylon parallelopipedum* (Melsheimer). Also, LaFage and Williams (1979) give more information.

Life Cycle and Climatic Effects

Infestations begin when adults lay eggs in unfinished, untreated wood. The total life cycle consists of egg, larva, pupa, and adult stages and typically requires 1 year. Egg and pupal stages last about 2 weeks; the larval stage varies in length. If wood has high starch content (0.3 percent) and is stored in warm temperature (70° to 90°F) and high humidity (70 to 90 percent), larvae will feed for only 3 to 10 months; if starch, temperature, and humidity are low (less than 0.3 percent, 50°F, and 60 percent, respectively) larvae may feed for 3 to 4 years. Larvae cause extensive internal damage by boring meandering feeding tunnels within wood that are filled with powder. Adult beetles chew small round holes in wood surfaces as they emerge to infest the same wood or to fly to other wood. Most adults die within a month, but adults of some species may live as long as 3 months.

Although beetles damage wood when its moisture ranges from 6 to 30 percent, larvae develop fastest when moisture is 14 to 16 percent (moisture occurs in wood stored at 70 to 80 percent relative humidity). Development is best at 70° to 80°F, but larvae can tolerate a broad range of constant or slowly changing temperatures.

Wood Species Attacked

Susceptible woods include the sapwood of many domestic hardwoods such as ash, cherry, elm, hickory, pecan, red oak, white oak, and walnut. Imported hardwoods, including banak (*Virola* spp.), lauan/meranti (*Shorea* and *Parashorea* spp., often sold as Philippine mahogany), and obeche *(Triplochiton scleroxylon* K. Schum), are also infested frequently. Softwoods such as cedar, fir, pine, and spruce lack sufficient starch and are esentially immune, as are many hardwoods, including basswood, beech, birch, and poplar. The susceptibility of many tropical hardwoods to lyctid beetles is given by Berni and others (1979), Bolza and Keating (1972), and Keating and Bolza (1982).

When Wood is Attacked

Wood most often becomes infested when large quantities of unfinished, recently processed lumber and other products are concentrated at sawmills, manufacturing plants, and warehouses. Recently processed wood has the most nutrients and is most attractive to beetles. However, products in use or stored logs are sometimes attacked. Infested wood that is later finished is often completely destroyed because unfinished wood in the emergence holes of adults is attacked repeatedly.

Beetles can readily infest susceptible wood that has been kiln-dried or fumigated. Kiln-dried lumber and products made from dried lumber often may be infested and sold unwittingly because wood may contain eggs or larvae for a year or more without showing external signs of their presence.

Lonnie H. Williams is a Principal Entomologist, Southern Forest Experiment Station, USDA Forest Service, Gulfport, Miss. 39505.

The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an offical endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed have been registered. All pesticides must be registered by appropriate State and/or Federal agencies before they can be used.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife — if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.